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PARALVINELLA HESSLERI, NEW SPECIES OF ALVINELLIDAE (POLYCHAETA) FROM THE MARIANA BACK-ARC BASIN HYDROTHERMAL VENTS

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Abstract.—A new alvinellid polychaete, *Paralvinella hessleri,* from the Mariana back-arc basin hydrothermal area is described. It is morphologically close to *P. bactericola, P. palmiformis* and *P. grasslei,* from active vents in the eastern Pacific. Biogeographical implications are discussed herein.

The first alvinellid polychaete, *Alvinella pompejana,* was collected by D.S.R.V. *Alvin* from honeycomb-like structures on the chimney walls of active hot vents at 21°N Eastern Pacific Rise hydrothermal site (Desbruyères & Laubier 1980). Since that time, specimens collected on American, French and Canadian submersible dives on the east Pacific ridges have expanded our knowledge of alvinellids. These worms until now have been exclusively sampled associated with warm and hot deep-sea vents in the eastern Pacific ridge system. Six species and one sub-species, belonging to two genera, have been described from the East Pacific Rise, Galápagos Ridge, Guaymas Basin, Explorer and Juan de Fuca Ridges (Desbruyères & Laubier 1982, 1986, 1989). The examination of all these taxa led us recently (1986) to propose the erection of a new family Alvinellidae, which seems to be primitive within the order Terebellida.

Recently, an *Alvin* study of the Mariana Back-Arc Basin resulted in the discovery of two large vent areas at 3600–3700 m. The vent fields lie on the flank of active axial volcanoes (Craig et al. 1987) with a striking hydrothermal fauna. According to Hessler et al. (1987), patterns of faunal distribution at the vents are similar to those seen on the East Pacific Rise although the dominant organisms belong to different and new taxa.

The alvinellid species described here were sent to us by R. R. Hessler of the Scripps Institution of Oceanography. The specimens were collected by submersible *Alvin* on the rocks directly exposed to venting water whose temperature was recorded up to 25°C.

Order: Terebellida
Family: Alvinellidae Desbruyères & Laubier, 1986
Paralvinella hessleri, new species

Type locality, material examined.—Thirty three specimens collected during *Alvin* dives 1831 (04/16/87) at Illium vent site (depth 3595 m, 18°12.8′N and 144°42.4′E), 1843 (05/04/87) and 1845 (05/06/87) at Alice Springs (depth 3640 m, 18°12.6′N and 144°42.4′E). Holotype (dive 1831) deposited in the collections of the Division of Worms, National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM 119431). Paratypes (number 5) from the same dive deposited in the collections of the "Laboratoire des Vers," Muséum national d'Histoire naturelle de Paris (UC 90/A 908).

Etymology.—This species is named for Dr. Robert R. Hessler, Scripps Institution of Oceanography, leader of the biological study of the Mariana vents.

Description.—Holotype 22 mm in length and 2.1 mm in greatest width with 60 setigerous segments (Fig. 1A). Paratypes range from 52 to 61 setigerous segments with the majority having 58 to 61. Color pinkish after preservation in ethanol, with capillary setae yellow, modified setae brown. Body gradually tapering from about setigerous segment 30 to the end of the body. Ventral shields in the anterior third.

Prostomium medially reduced with a median incision and two well developed lateral lobes ventrally enclosing peristomium (Fig. 2A). Buccal apparatus complex, comprising a ventral globular bulky organ (a), two lateral, large and strong pointed tentacles (b) bearing a deep groove without ciliation, and many grooved and ciliated smaller tentacles (c) inserted in two groups on a quadrilobed upper lip (Fig. 3A). The whole apparatus or each part (e.g. ciliated tentacles, large tentacles and globular organ) eversible.

First segments (II and III) achaetous and fused to the first three setigerous; these five segments are not discernible ventrally. The first 15 to 20 setigerous segments with notopodia only.

First three notopodia smaller than others and dorsally elevated. Branchial region formed by segments III to VI (an achaetous segment plus three setigerous segments). Branchiae four pairs, all similar, strong and regularly attenuated, and arranged in two adjacent groups. Branchial stem with large number of slender filaments inserted on two opposite narrow areas; branchial filaments cylindrical with small secondary filaments arising on two opposite lines. Setiger 4 (segment VII) with a median dorsal expansion which protrudes forward (Fig. 1B).

Notopodia, from setiger 4 to 13–17 (7 excepted), cylindrical with a dorsal digitiform lobe (Fig. 3C) bearing two groups of capillary setae, one with short and the other with long. Setigerous segment 7 strongly modified, lacking cylindrical notopodia but bearing, on each side, 4 to 5 very large acicular notopodial hooks directed posteriorly. Setigerous segment 8 with cylindrical notopodium and very strong digitiform lobe directed forward (Fig. 2B and 3C).

Cylindrical notopodia and uncinigerous neuropodial tori on each segment from segment 15–20, both to end of body. Uncini numerous (20 to 50 per torus) in single rows, with teeth facing anteriorly (retrogressive situation). Uncini with one main tooth surmounted by one smaller secondary tooth (Fig. 3B) as in all other alvinellids. Pygidium rounded with inconspicuous papillations.

Tubes whitish and corneous in aspect, amoeba-like in shape with long anchor filaments (Fig. 2D). Tube walls thick and multilayered. Inner surface bearing huge filamentous bacterial mats.

Ecology.—All the specimens have been found in tubes on rocks directly exposed to venting water whose temperature was recorded up to 25°C. The holotype was collected inside Illium vent site from Whelk's Club hot vent area near a hot smoker whose temperature is 282°C.

Discussion

Since the discovery of the first Alvinellinae, another genus, five species and one sub-species have been described, all sampled from active hydrothermal vent areas of the eastern Pacific; a new family was erected within the order Terebellida (see Desbruyères & Laubier 1986, Holthe 1986) to accomodate these unusual polychaetes.

Specimens collected from the Mariana Back-Arc Basin hydrothermal vents undoubtedly belong to *Paralvinella* and are morphologically close to *Paralvinella grasslei* Desbruyères & Laubier, 1982, *P. palmiformis* Desbruyères & Laubier, 1986, and *P. bactericola* Desbruyères & Laubier, 1989. All share the following features: prostomium medially reduced with two lateral expansions, four pairs of bipinnate branchiae with secondary slender filaments in opposite arrangement, uncini present posterior to the modified segment and buccal organ complex with large paired, grooved non-cil-

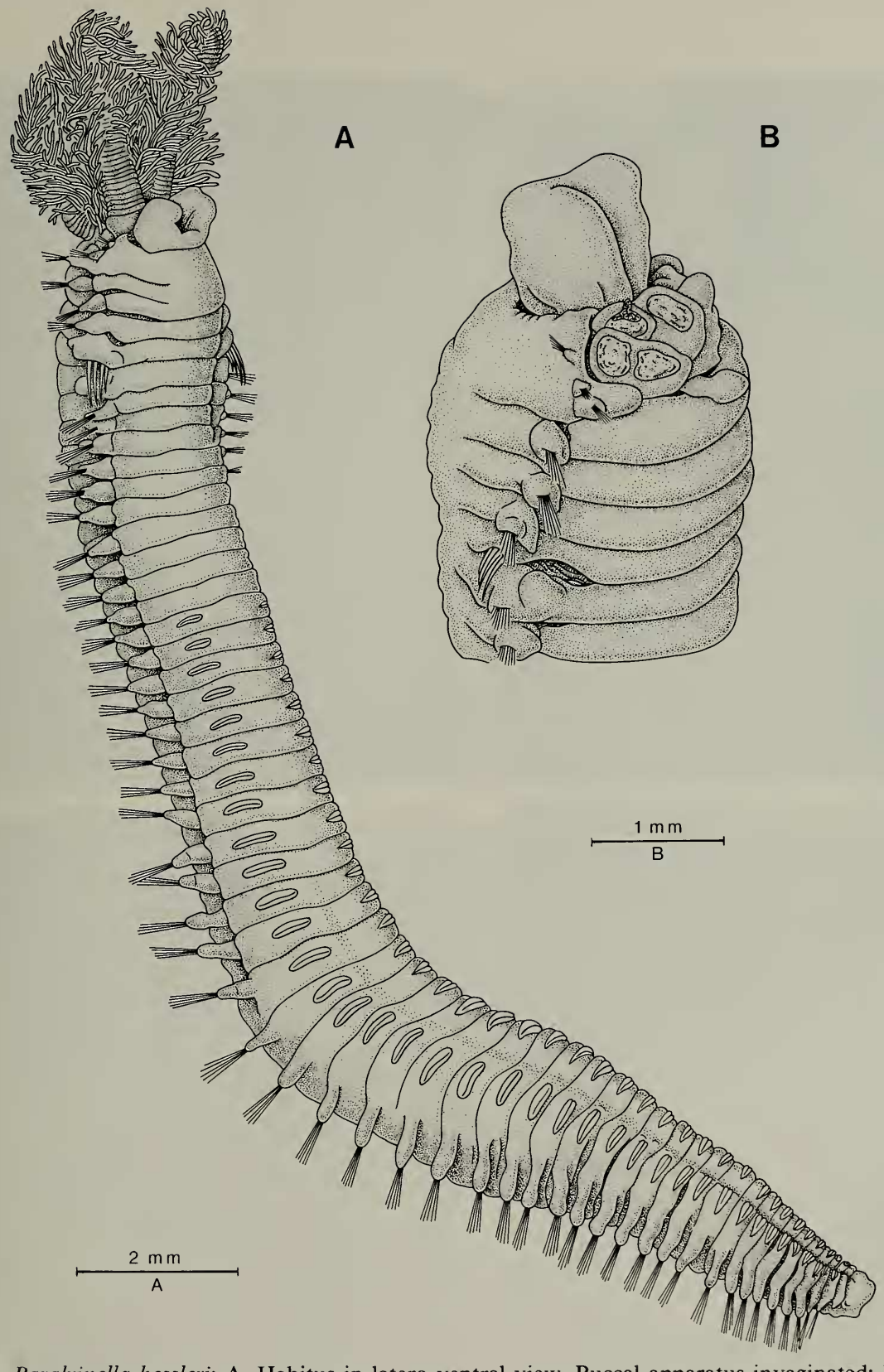

Fig. 1. *Paralvinella hessleri*: A, Habitus in latero-ventral view. Buccal apparatus invaginated; B, Anterior end in dorso-lateral view, branchiae removed.

iated tentacles. *Paralvinella hessleri* differs from these three species by the shape of the buccal structures, the first appearance of the uncinigerous tori, the presence of a stouter notopodial lobe on setiger 8 and the fusion of the first five segments as in *Alvinella* spp. (Figs. 2B and 4).

Paralvinella grasslei and *P. palmiformis* are closely related, while *P. bactericola* differs from both by the structure of its buccal

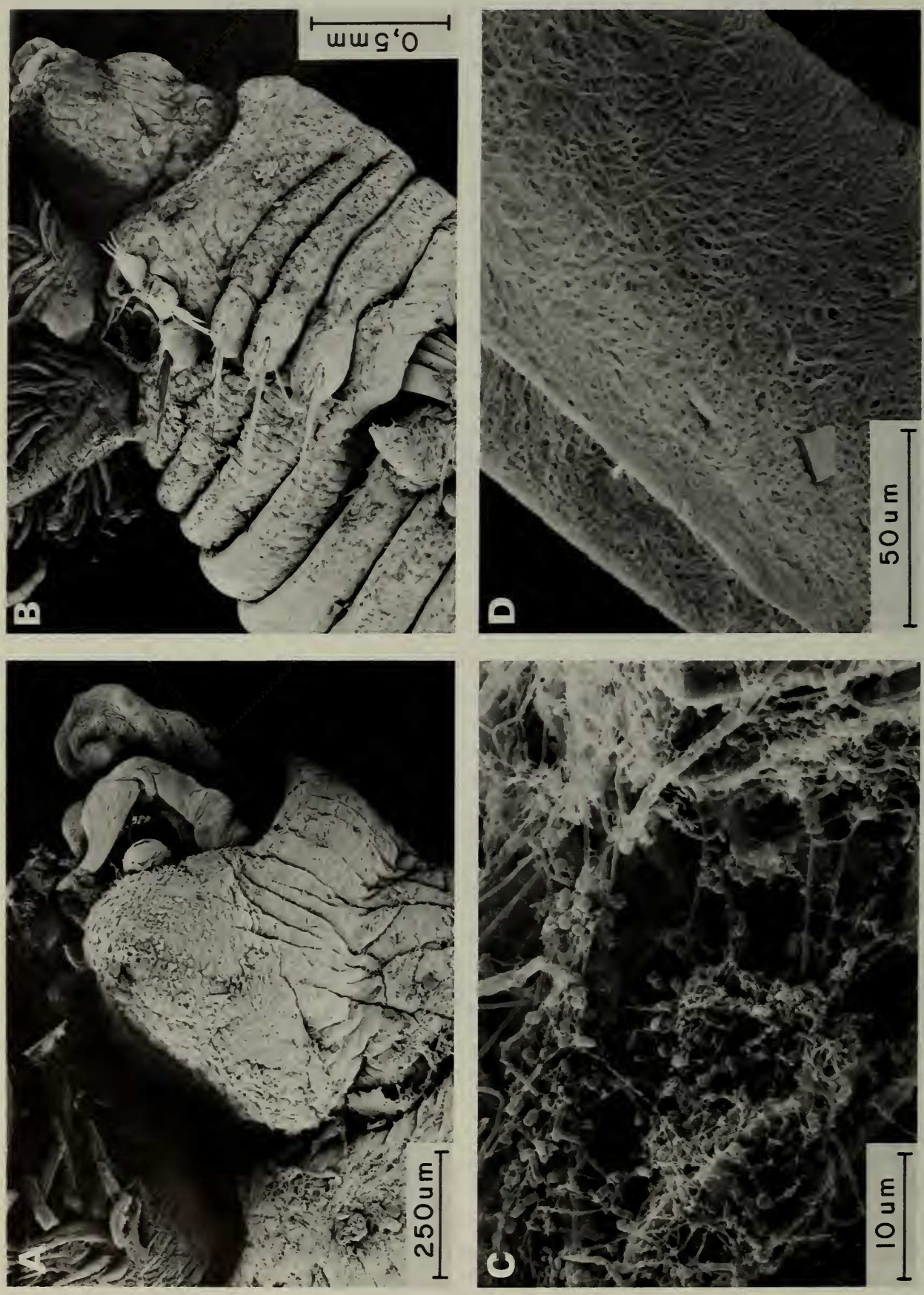

Fig. 2. *Paralvinella hessleri,* scanning electron photomicrographs: A, Lateral lobes of the prostomium enclosing, ventrally, the peristomium, (right side, lateral view); B, Branchial fused segments in right side lateral view; C, Bacterial mats on the inner part of the tube; D, Anchor filaments of the tube.

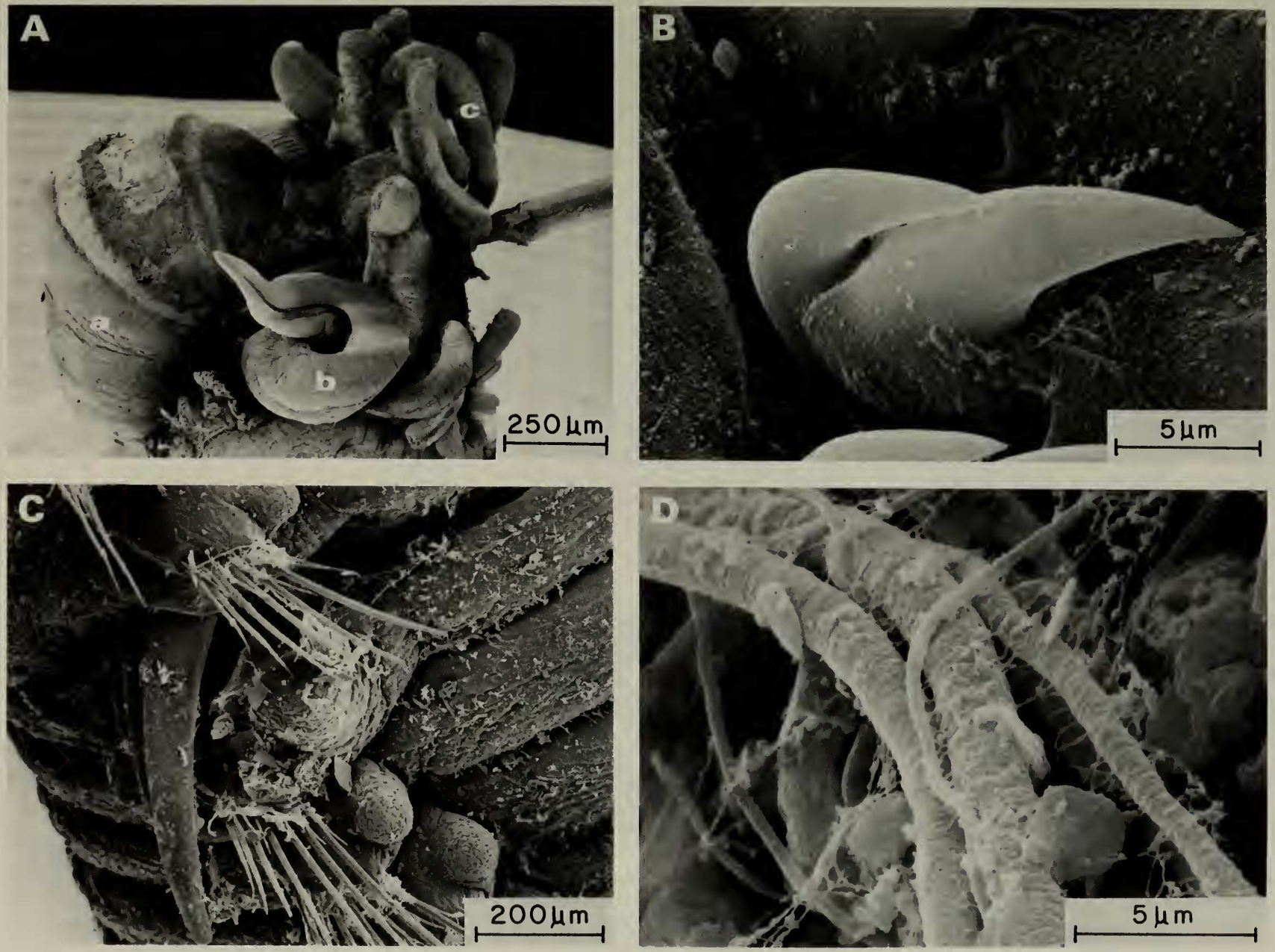

Fig. 3. *Paralvinella hessleri,* scanning electron photomicrographs: A, left side lateral view of the everted buccal apparatus, (a) ventral organ, (b) lateral paired tentacles, (c) buccal grooved tentacles; B, Uncinus of a median setigerous segment; C, Left side latero-dorsal view of the left transformed notopodium (seventh setigerous segment); D, Filamentous bacteria from the inner part of the tube.

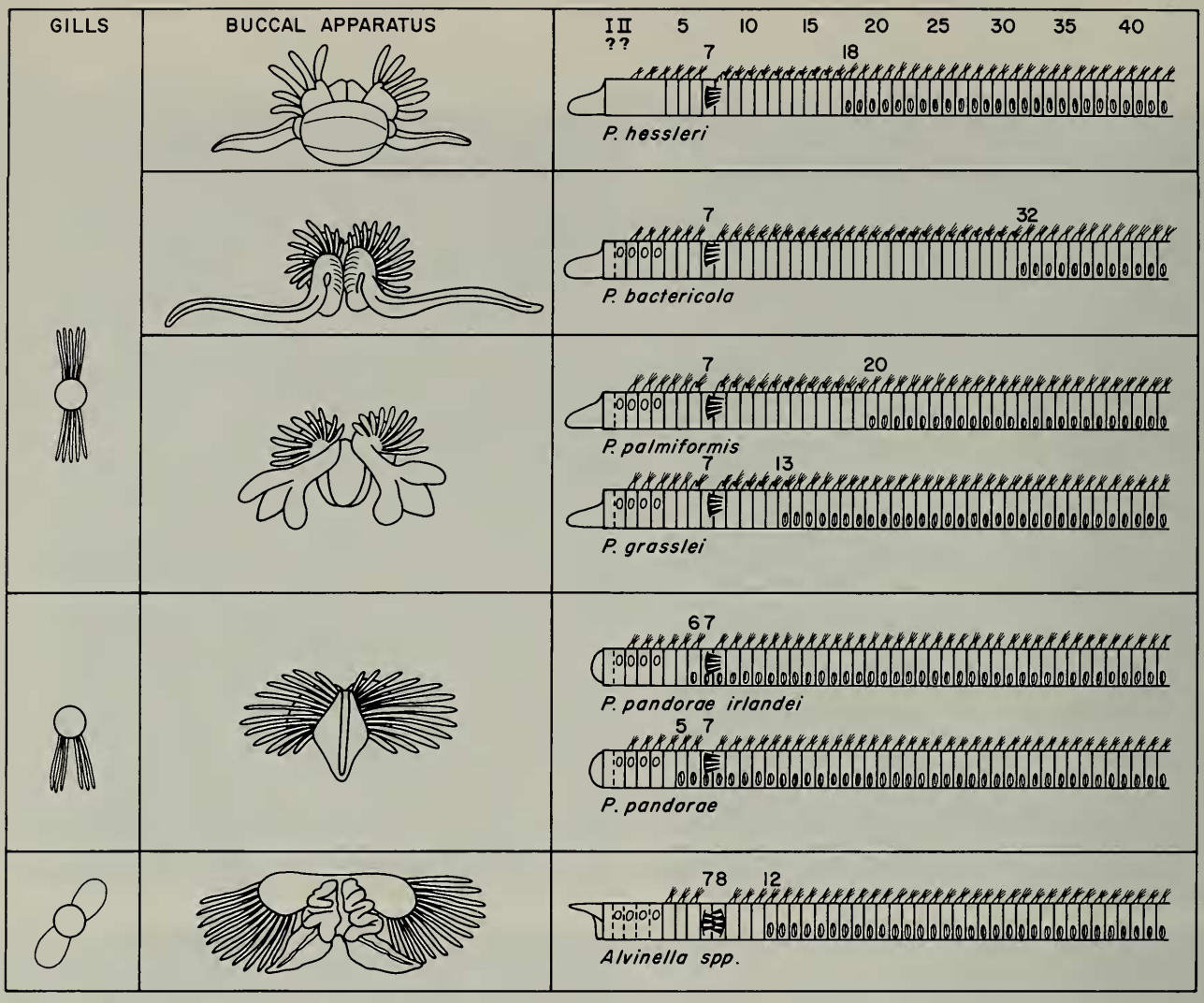

Fig. 4. Distinctive characters of the seven species and subspecies of Alvinellidae.

apparatus and the posterior position of the neuropodia. Due to its buccal apparatus with two large and strong pointed tentacles, *P. hessleri* has close relationship with *P. bactericola.* On the contrary, the pair of sibling species *P. grasslei* and *P. palmiformis* is characterized by two buccal structures ending in three rounded lobes. The ventral globular bulky organ of *P. hessleri* resembles the ventral lobe of *P. grasslei* and *P. palmiformis.* Still, its absence in *P. bactericola* is not definitely established due to the small size of the sample and the possibility of invagination. The first neuropodium of *P. hessleri* (setigerous segment 18) appears in an intermediate position between *P. grasslei* (setigerous segment 13) and *P. palmiformis* (setigerous segment 20). In *P. hessleri,* the fusion of anterior segments and the tendency towards reduction and constancy in number of segments can be considered as apomorphous conditions within Alvinellidae. At present, we can consider *P. hessleri* as a "recent" species within the genus; it exhibits clear relationship with the group *P. bactericola* and *P. grasslei* and *P. palmiformis.*

The morphological likeness between *P. bactericola* and *P. hessleri* led us to assume a common ancestor. The Mariana Back-Arc Basin is located about 5000 nautical miles west from the eastern Pacific ridge system where all other *Paralvinella* have been found. This young back-arc basin, probably less than 10 million years old, has no physical connection with the mid-oceanic ridge system and is strongly isolated. Such habitat isolation, combined with close relationship

between *P. hessleri* and *P. bactericola,* led us to assume 1) the existence of very efficient dispersal mechanisms, or 2) the possibility that submarine volcanoes or organic matter patches could act as stepping stones for *Paralvinella* dispersal. The youngest stage of *Paralvinella,* presently known, is a twelve-segmented erpochaeta of *P. pandorae irlandei* (Desbruyères & Laubier 1986). By comparison with a few examples of ampharetid species, we recently concluded that alvinellids should probably have a short larval life (Desbruyères & Laubier 1986), while the opposite hypothesis could be supported by comparison with several terebellids. The hypothesis of submarine volcanoes acting as stepping stones for the dispersal of benthic species is supported by recent results on branchiate polynoids (Desbruyères & Laubier 1988). Concerning the two sibling species *P. palmiformis* and *P. grasslei,* it is though that they arise from a common ancestor by allopatric speciation after the original area was separated into two distinct hydrothermal districts, north and south of the Oregon subduction zone some 26 million years ago by the overlapping American plate (Tunnicliffe 1988). At the opposite *P. bactericola* and *P. grasslei* dwell close together in Guaymas Basin, demonstrating a strong sympatric speciation: the first associated with bacterial mats, the second with vestimentiferans and sulfides.

Acknowledgments

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